GROUND-LEVEL OZONE (O_3)

NATURE AND SOURCES

Ozone can be helpful or harmful, depending on its location. In the stratosphere – 10 to 30 miles above the Earth – a layer of ozone provides protection by filtering the sun's harmful rays. But at ground level, ozone can harm both human health and the environment.

Ground-level ozone forms when emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in the presence of sunlight. These ingredients come from motor vehicle exhaust, power plant and industrial emissions, gasoline vapors, chemical solvents, and some natural sources. Because ground-level ozone forms more readily in hot, sunny weather, it is known as a summertime air pollutant. High ozone levels can occur anywhere: wind can carry ozone and the pollutants that form it hundreds of miles away from their original sources. Changes in emissions, combined with changing weather patterns, contribute to yearly differences in ozone concentrations from region to region.

HEALTH AND ENVIRONMENTAL EFFECTS

Breathing ground-level ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and congestion. It can aggravate bronchitis, emphysema, and asthma. Ozone can also reduce lung function and inflame the lining of the lungs. Repeated exposure may permanently scar lung tissue. People with lung disease, children, older adults, and people who are active outdoors can be affected when ozone levels are unhealthy.

Ground-level ozone can also have detrimental effects on plants and ecosystems. These effects include (1) interfering with the ability of sensitive plants to produce and store food, (2) damaging the leaves trees and other plants, and (3) reducing crop yields and forest growth.

TRENDS IN OZONE CONCENTRATIONS

Nationally, ozone concentrations were 9 percent lower in 2006 than in 1990, as shown in Figure 6. The trend showed little change throughout the 1990s with a notable decline after 2002. Concentrations in 2006 were the second lowest over the 17-year period.

For each monitoring location, the map in Figure 7 shows whether ozone concentrations increased, decreased, or stayed about the same over the trend period. The sites that showed the greatest improvement were the ones with the highest concentrations in 1990. For example, southern California had some of the highest ozone concentrations in the nation in 1990, but showed more improvement than any other area (a decline of over 0.040 ppm). Other sites in California, plus the Northeast, Midwest, and Texas showed more than 0.021 ppm improvement.

Eleven sites showed an increase of greater than 0.005 ppm. Of the 11 sites that showed an increase, nine had air quality concentrations below the level of the ozone standard (0.08 ppm) for the most recent year of data; only Maricopa County, Ariz., and Clay County, Mo., were above.

Figure 8 shows a snapshot of ozone concentrations in 2006. The highest ozone concentrations were located in California and Texas. Overall, the greatest improvements were in or near urban areas while the greatest increases were in less populated or rural areas. Increases in rural areas raise concerns about ozone's detrimental effect on plants and ecosystems.

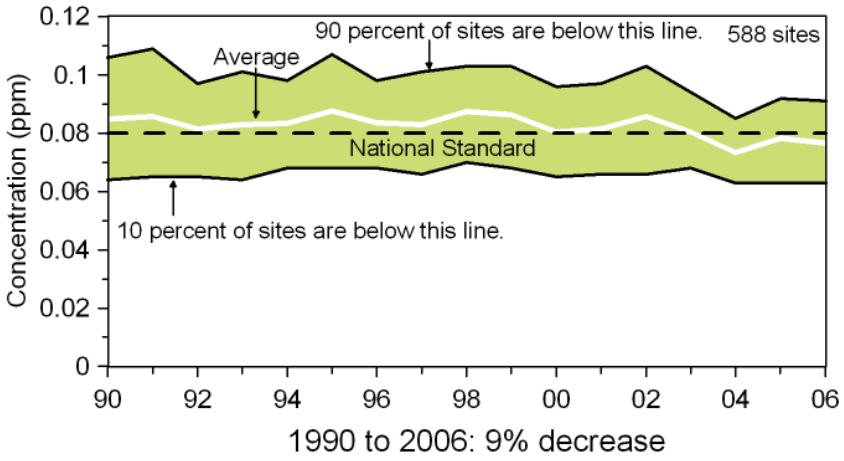


Figure 6. National 8-hour ozone air quality trend, 1990-2006 (average of annual fourth highest daily maximum 8-hour concentrations).

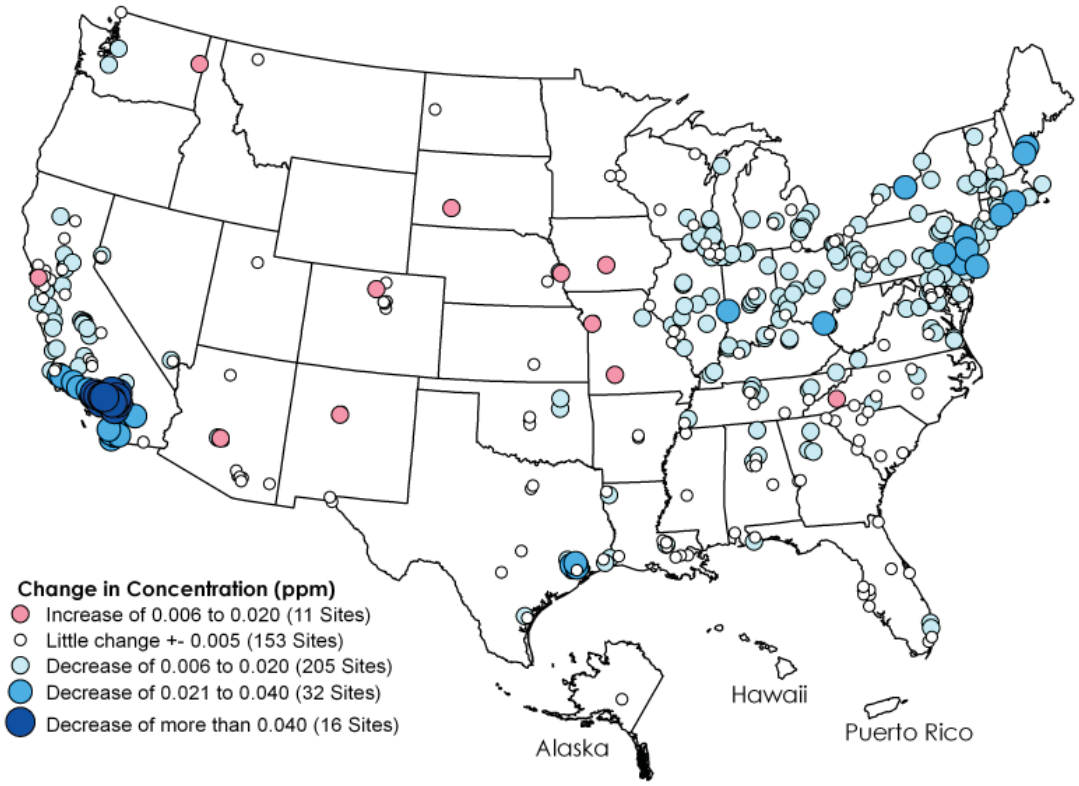


Figure 7. Change in ozone concentrations in ppm, 1990-1992 vs. 2004-2006 (3-year average of annual fourth highest daily maximum 8-hour concentrations).

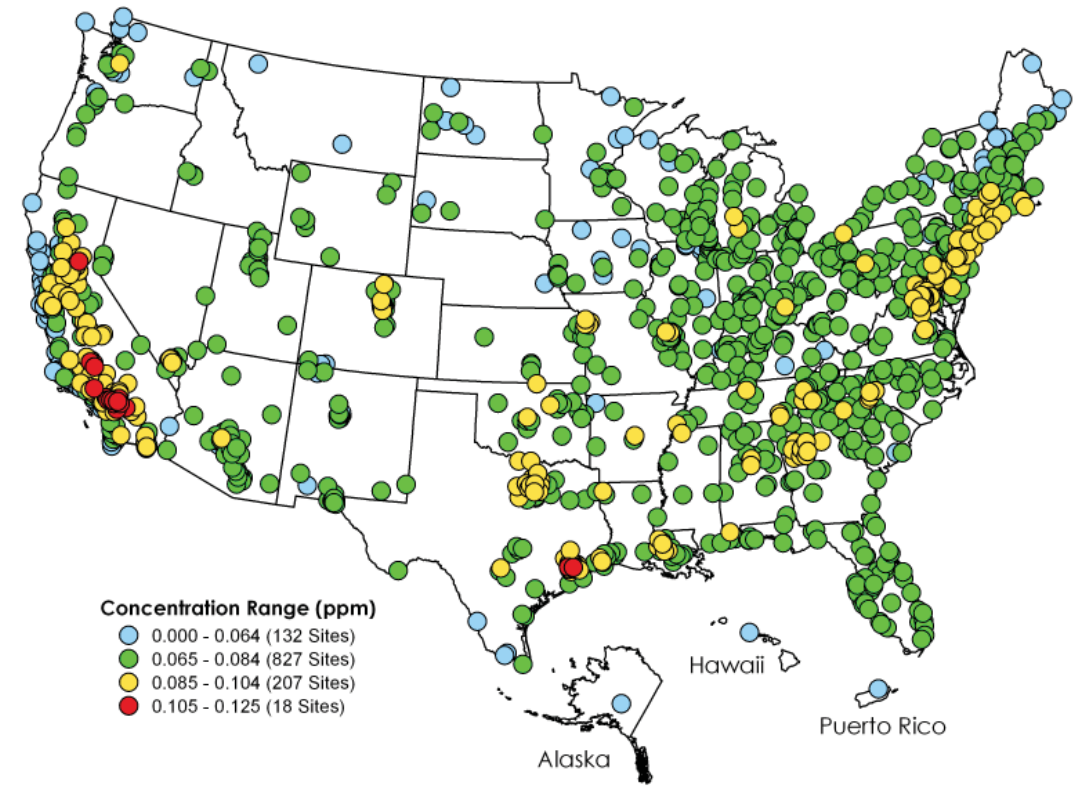


Figure 8. Ozone concentrations in ppm, 2006 (fourth highest daily maximum 8-hour concentrations).

Figure 9 shows that all selected areas in the East had fewer unhealthy ozone days in 2006 compared with the average from the previous five years (2001-2005), with the exception of Atlanta and Kansas City. In the West, Los Angeles and Sacramento had the most unhealthy ozone days in 2006 (over 40 days each), though Los Angeles had fewer unhealthy ozone days in 2006 than its average from the previous five years.

TRENDS IN OZONE-FORMING EMISSIONS

Ozone is formed by the reaction of VOCs and NO_x in the presence of sunlight. Because ozone is mostly a summer-season pollutant, emissions are shown here for the summer only (May-September). The year 1997 was selected as a base year for these ozone analyses because of the change in methodology for VOC and NO_x emissions in 1996. Figure 10 shows that during the period 1997 to 2006, summer emissions of VOCs and NO_x decreased 20 and 30 percent, respectively. The majority of these emission reductions were from transportation and fuel combustion sources. After 2002, the largest reductions were in NO_x emissions from fuel combustion sources.

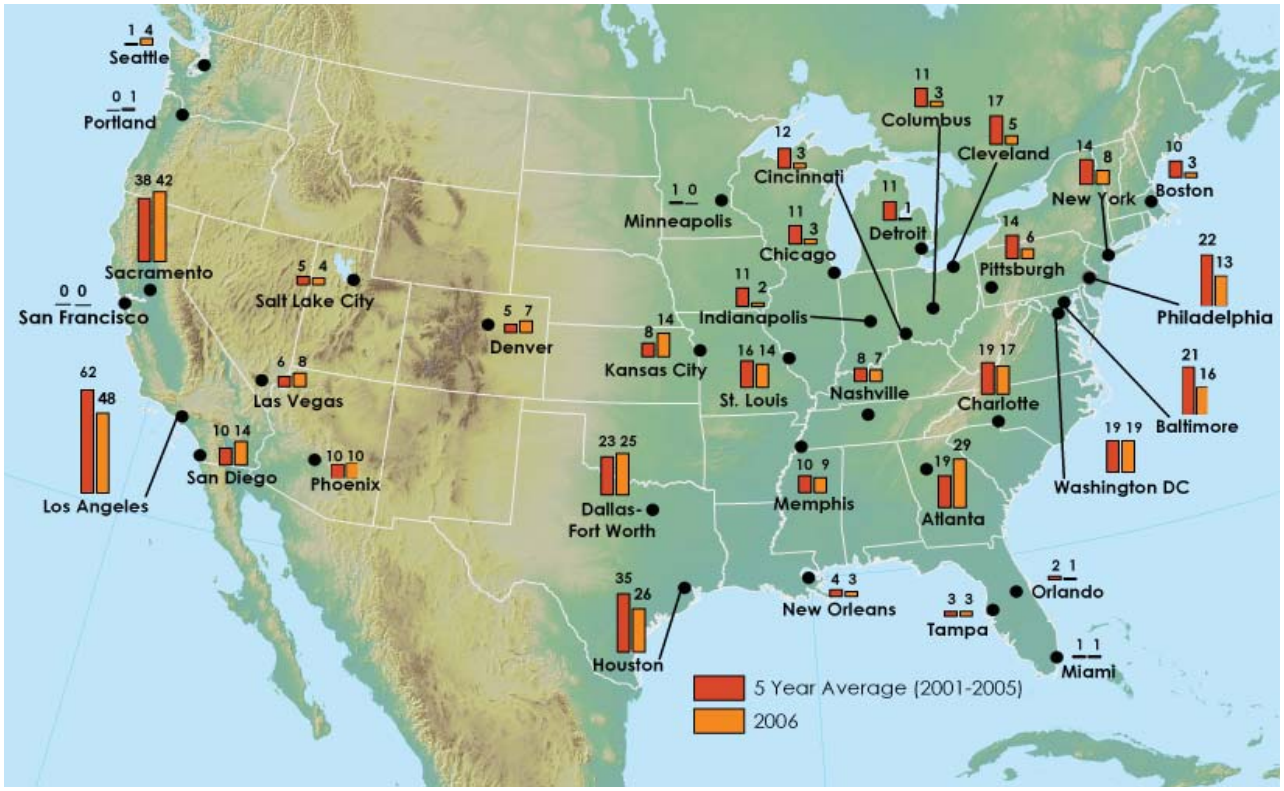


Figure 9. Number of days reaching Unhealthy for Sensitive Groups for ozone on the AQI for 2001-2005 (average) vs. 2006.

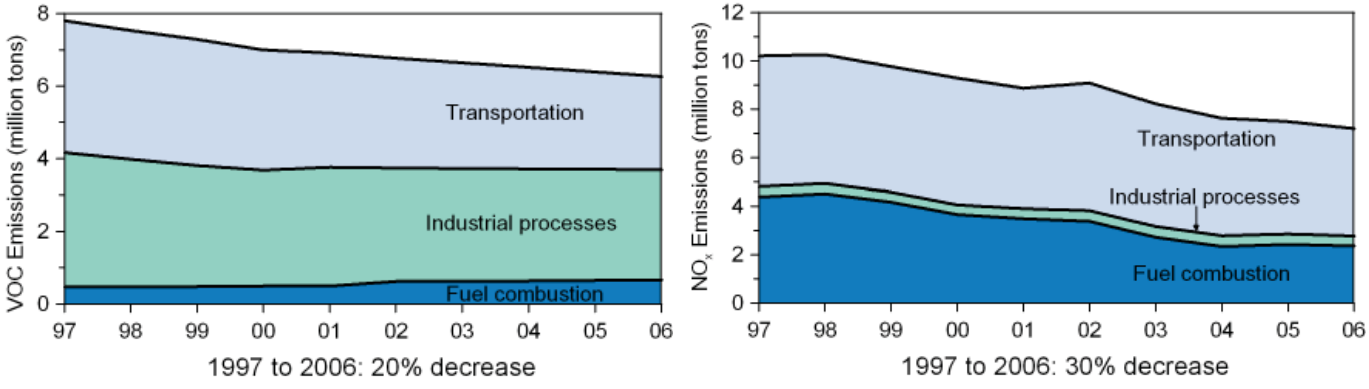


Figure 10. National trends in summertime ozone-forming emissions, 1997-2006.

Notes: Trends do not include miscellaneous emissions. Except for NO_x emissions from electric generating units, summertime emissions of VOC and NO_x were estimated using 5/12 of annual emissions.

WEATHER INFLUENCE ON OZONE

Weather plays an important role in the formation of ozone. A large number of hot, dry days can lead to higher ozone levels in any given year, even if ozone-forming emissions do not increase. Figure 11 shows ozone trends for 1997 through 2006, before and after adjusting for weather at selected sites. The hot, dry summer of 2002 contributed to high concentrations of ozone; after those levels were adjusted to remove the influence of weather, ozone concentrations were much lower. In 2004, the weather was cooler and more humid, so ozone was less likely to form; removing the influence of weather shows higher ozone concentrations that year.

Ozone concentrations decreased 3 percent from 1997 to 2006. When the influence of weather is removed, the effect of changes in emissions on air quality is easier to see, and ozone shows a 7 percent decrease from 1997 to 2006. Much of the improvement occurred in the East. The average decrease among 79 sites in the East was 10 percent, while the average decrease among 54 sites in the rest of the U.S. was 1 percent.

In Figure 11, both trend lines show a decline in ozone concentrations between 2002 and 2004. This decline is mostly due to reductions in fuel combustion NO_x emissions under the Acid Rain Program, which began in 1995, and implementation of the NO_x SIP Call rule, which led to sustained reductions in the East beginning in 2003 and 2004. The weather-adjusted trend line confirms that the decrease in ozone concentrations between 2002 and 2004 was caused by something other than the weather. The weather-adjusted trend line also shows lower ozone concentrations in 2005 and 2006, with concentrations similar to the 2004 levels. Thus, ozone improvements achieved through emission reductions in 2004 were maintained.

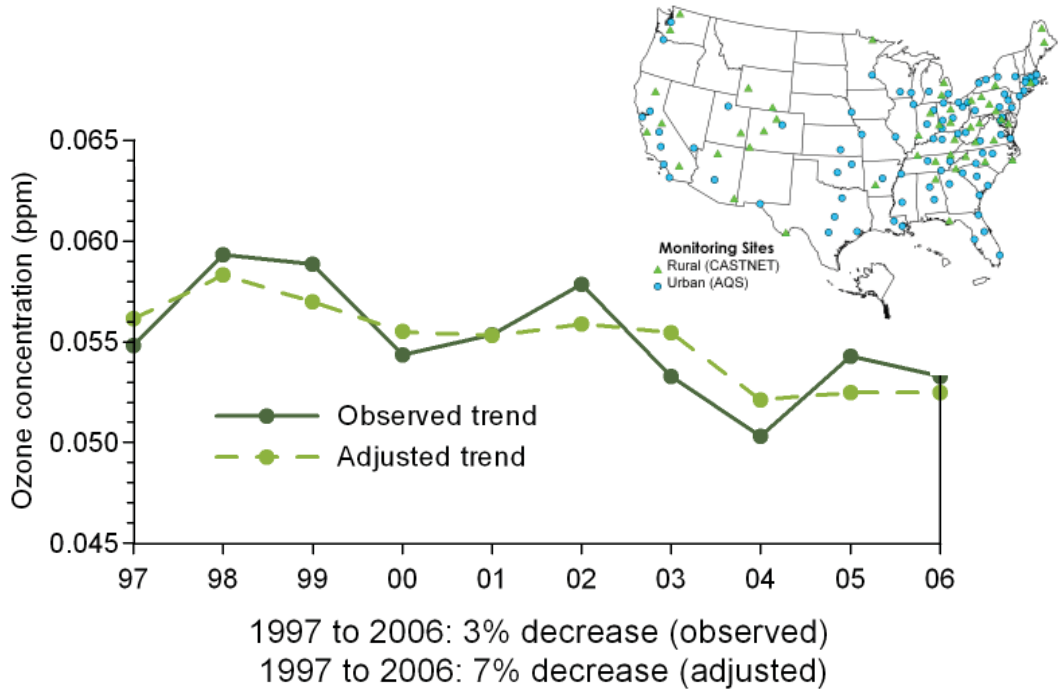


Figure 11. Trends in average summertime daily maximum 8-hour ozone concentrations, before and after adjusting for weather, and the location of urban and rural monitoring sites used in the average.

Notes: Urban areas are represented by multiple monitoring sites. Rural areas are represented by a single monitoring site. For more information about the Air Quality System (AQS), visit http://www.epa.gov/ttn/airs/airsaqs. For more information about the Clean Air Status and Trends Network (CASTNET), visit http://www.epa.gov/castnet.

Air Quality, Emissions, and Weather

Ozone and some particles are formed by the reaction of emissions in the presence of sunlight, so both emissions and weather conditions contribute to air pollution levels. As weather conditions vary from year to year, pollutant levels could be higher in years with weather conditions conducive to their formation—even when emission control programs are working as expected.

To better understand how these pollutants are changing, EPA assesses both the changes in emissions as well as weather conditions. EPA uses a statistical model to remove the influence of weather. This provides a clearer picture of the underlying pollutant trend from year to year, making it easier to see the effect of changes in emissions on air quality.

For information on the statistical model, read "The effects of meteorology on ozone in urban areas and their use in assessing ozone trends," by Louise Camalier, William Cox, and Pat Dolwick of the U.S. EPA. *Atmospheric Environment*, In Press, 2007.

Figure 12 shows the effect of the NO_x SIP Call in the East, where the program was implemented. Weather-adjusted average summertime ozone concentrations were compared between the summers of 2000 and 2001 versus 2005 and 2006 (the years before and after the largest NO_x reductions). The large declines in ozone occurred throughout the central portions of the region, including North Carolina, Virginia, West Virginia, Pennsylvania, and Ohio. On average, ozone concentrations declined by 0.005 ppm (about 8 to 10 percent) over the region.

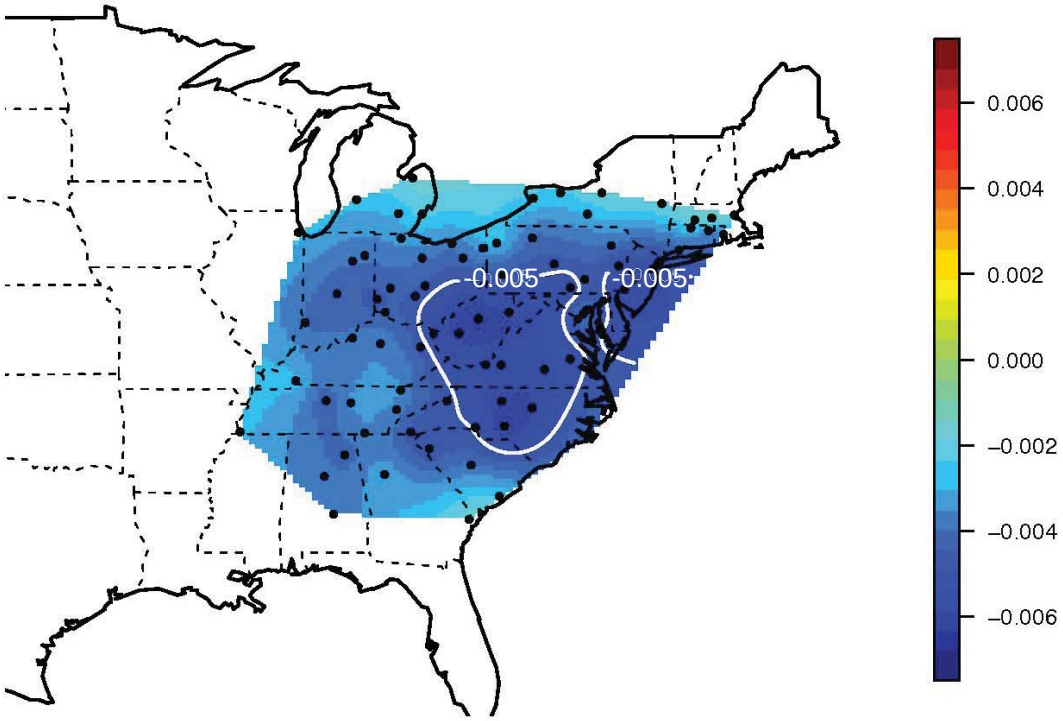


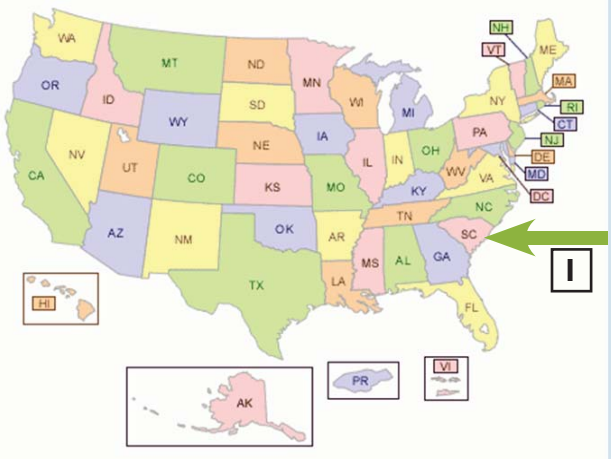
Figure 12. Changes in summertime daily maximum 8-hour ozone concentrations (ppm) between 2000-2001 (average) and 2005-2006 (average). Concentrations have been adjusted using weather variables such as temperature and humidity. Estimated changes for locations farther from monitoring sites (dots on map) have the largest uncertainty.

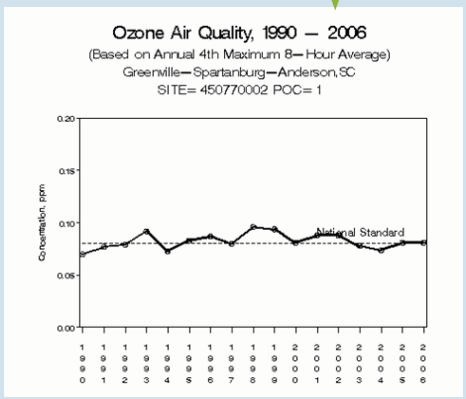
Future Air Programs Will Bring Cleaner Air to Many Areas

EPA's Clean Air Interstate Rule (CAIR) will help reduce particle pollution and ozone in the East by cutting emissions of SO_2 by 70 percent and NO_x by 60 percent over 2003 levels. The Clean Air Mercury Rule (CAMR) will build on CAIR to reduce utility emissions of mercury by nearly 70 percent at full implementation. This rule makes the United States the first country to regulate mercury emissions from utilities. In addition, recent national mobile source regulations will help reduce emissions of toxic air pollutants, PM, NO_x, and VOCs from new passenger vehicles, heavy-duty diesel engines, and other mobile sources. Together, these programs create a strategy to reduce multiple air pollutants throughout the U.S.

Where You Live

Air quality trends can vary from one area to another. Local trends are available at individual monitoring locations for all pollutants with enough historical data, http://www.epa.gov/airtrends/where.html. Trends in ozone adjusted for weather conditions are also available, http://www.epa.gov/airtrends/weather.html.





Local Trends in Ozone Levels

Simple steps to obtain more information

1. Pick the state
2. Pick the site
3. See the trend

http://www.epa.gov/airtrends/ozone.html